Vortex interaction and Kolmogorov spectrum

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An inviscid vortex dynamics simulation of interaction of several circular vortex rings produced the power spectrum which had the Kolmogorov $-5/3$ power law. The enstrophy spectrum, which is equivalent to the dissipation spectrum in homogeneous turbulence, had the $1/3$ power law in the same wavenumber range. The wavenumber range of the $-5/3$ power-law spectrum slightly depends on the number of the vortex rings and their initial configurations, being wider for smaller radius of core of the vortex rings. It was suggested that a uniform spatial distribution of high-vorticity regions is essential to have the $-5/3$ power law. The length scale of energy-containing eddies was obtained as the reciprocal of a wavenumber at which the energy spectrum attained a dominant peak, while the Kolmogorov length scale was defined as that of a wavenumber at which the enstrophy spectrum attained a dominant peak. Five invariants of inviscid vortical motion, i.e. the total energy, total momentum, total angular momentum, total helicity and total vorticity were maintained constant within tolerable deviations from the corresponding initial values until vorticity tends to diverge.

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